Space Weather Technical Forecast

Issued on Sunday, 04 February 2024 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of R1 throughout. Chance of G1 Sunday 04 February due to possible glancing blow from a CME.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured by GOES16, has been Low, with the peak flare in the last 24 hours a C7.7, peaking at 03/0554UTC. There are currently eight sunspots on the visible disc. AR3575 has continued to grow in the last few hours, becoming more compact and magnetically complex, and contains a delta spot. Newly numbered AR3576 has recently emerged on the southeast limb, which looks large and complex, although this is difficult to analyse at present due to foreshortening effect. All other spots have remained fairly stable or have decreased in size. No Earth-directed have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, were reflective of a slow-ambient solar wind regime. The solar wind speed was at background levels, between 300-320km/s. The solar wind density was predominately below average, before rising to near average, reaching 10ppcc by the end of the period. The IMF was weak throughout, at or below 4nT, while the north-south component ranged between -3 and +1nT. The phi angle was mostly positive (away from the Sun) until 03/1400UTC, with an abrupt change to mostly negative (towards the Sun), probably due to a SSBC (Solar Sector Boundary Crossing). The net result of the above solar wind measures was provisionally Quiet (Kp0-1) geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is currently slightly elevated above Background levels following the M6.8 flare on 29 Jan from Ex-AR3559, but remains well below the S1/Minor Radiation Storm threshold.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold but on a slight rising trend. At 04/0001UTC the 24-hour integrated fluence observation was 7e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Overall activity is most likely to be Low, but with an increasing chance of isolated M-class flares and a slight chance of an X-class flare, most likely from AR3575 in the southwest, but also from the newly numbered AR3576 emerging on the southeast limb.

Solar Wind / Geomagnetic Activity: A CME which left the Sun at 01/0743UTC may deliver a glancing blow early on day 1 (04 Feb). In addition there may be also be a fast wind enhancement from CH96/+ during this period, although likely more biased to effects on 04 into 05 February, with solar wind speeds perhaps reaching 450-500 km/s. Geomagnetic activity is expected to be mostly Quiet at first, but perhaps a chance of G1/minor storm should any CIR leading the fast wind from CH96/+ combine with glancing CME effects on day 1 (Sunday 04

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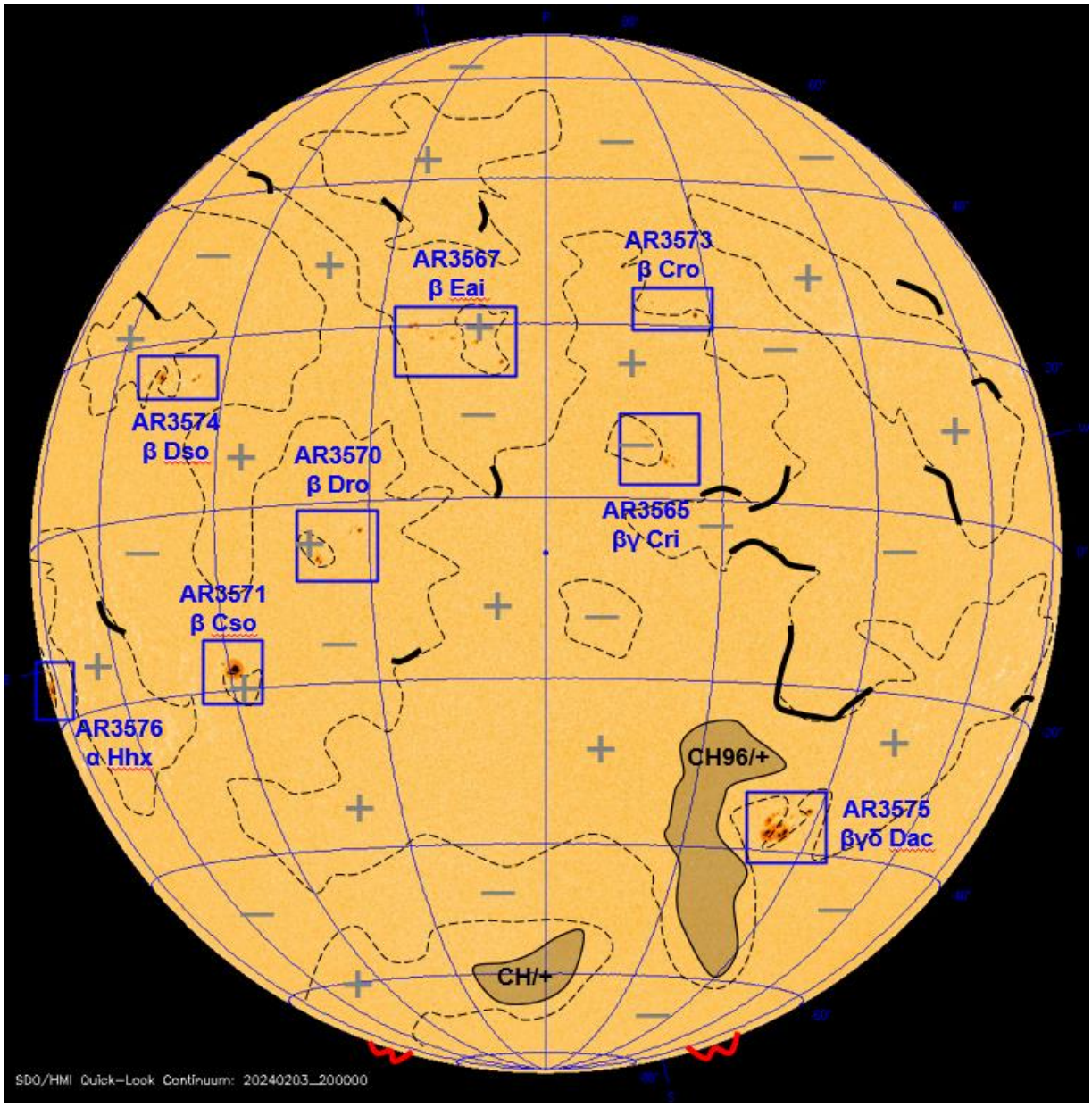
February) and a slight chance of similar activity on 05 Feb should this happen slightly earlier. A return to mostly Quiet conditions on days 3 and 4 (06-07 Feb).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain below the S1/Minor Radiation Storm level, with a daily slight chance of exceeding the S1 threshold during the period.

The high energy electron flux (greater than 2MeV) is expected to remain below High levels throughout the period, with exceedance of the Active fluence threshold considered unlikely.

Figure 1. Solar Analysis Valid 03/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which originated from a long-period C3 flare at 01/0743UTC near north-centre disc, may deliver a glancing blow early on 04 February. This is the only CME that features in the forecast at present, however it should be noted that confidence in this is lower than typical given the recent activity from AR3571.

In addition to the CME contribution to the geomagnetic forecast, there may be also be a fast wind enhancement from CH96/+ in the southern solar hemisphere due during this period. The majority of the HSS arrival is expected to straddle the UTC days of 04 and 05 February with solar wind speeds perhaps reaching 450-500 km/s. However, on the previous rotation, wind speeds barely reached 450 km/s with little geomagnetic response. At this time of year any response to positive polarity coronal holes is expected to be muted.

Geomagnetic activity is expected to be mostly Quiet at first, but perhaps a chance of G1/minor storm should any CIR leading the fast wind from CH96/+ combine with glancing CME effects on day 1 (Sunday 04 February) and a slight chance of similar activity on 05 Feb should this happen slightly earlier. A return to mostly Quiet conditions on days 3 and 4 (06-07 Feb).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	25	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1245	Partial	Plage area	NE	720km/s	04/0600UTC	Glancing blow possible

Figure 2: MOSWOC ENLIL shows arrival of high speed stream and possible glancing blow from a CME on 04 February. Ensemble is also shown below.

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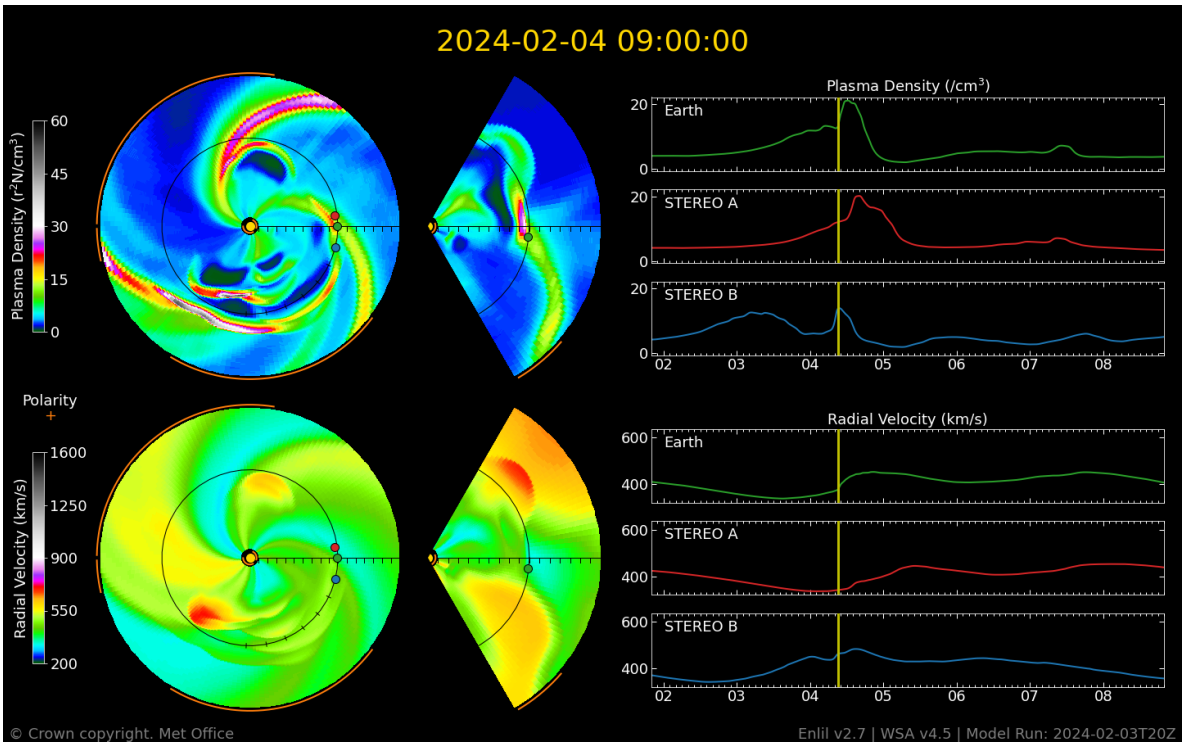

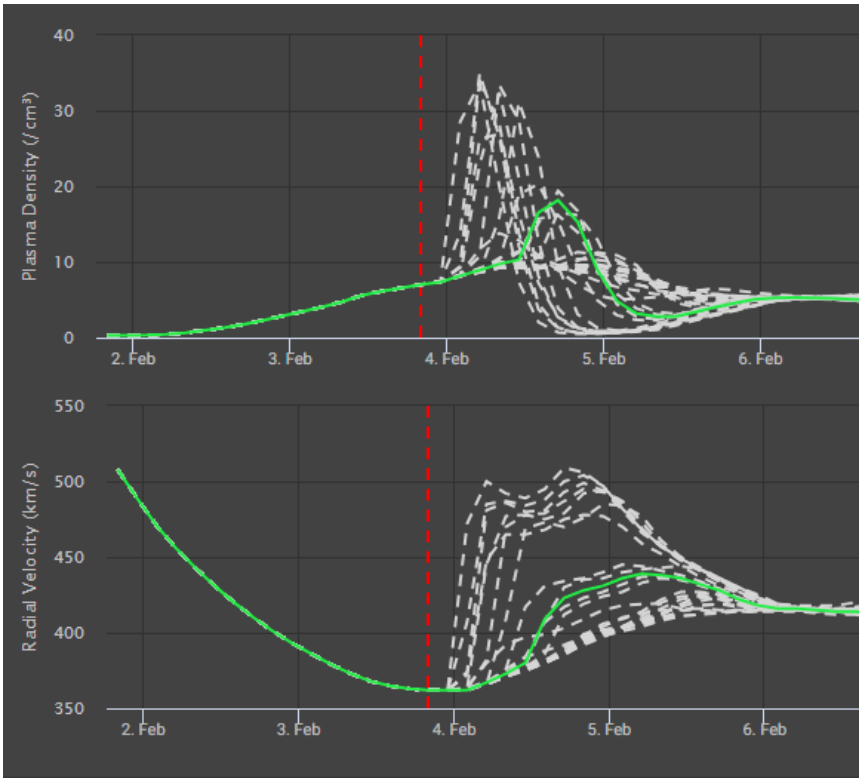

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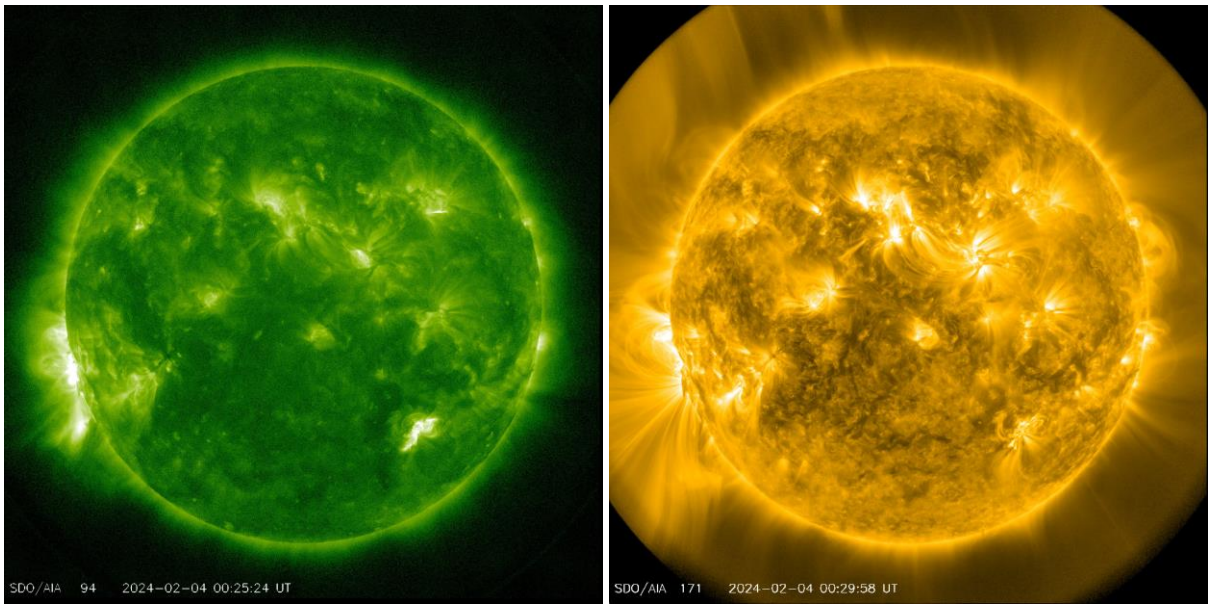
Radio Blackouts - X-Ray Flares:

There are currently eight sunspots on the visible disc. AR3575 has continued to grow in the last few hours, becoming more compact and magnetically complex, and contains a delta spot. There is a chance of AR3575 producing M-class flares, with a slight chance of an X-flare, given its complexity. There is a newly numbered AR3576 which has recently emerged on the southeast limb, although this is currently difficult to analyse due to foreshortening. SDO/AIA 94 imagery shows an increase in the bright flux associated with this new region, as does SDO 171, with significant magnetic looping observed. A better analysis of this region will be conducted once it rotates further onto the southeast quadrant. All other spots have remained fairly stable or have decreased in size.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	45	45	45	45
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: SDO/AIA 94 (left) shows bright flux associated with flaring on the eastern limb, with SDO/AIA 171 (right) showing increase in magnetic looping in the same area.



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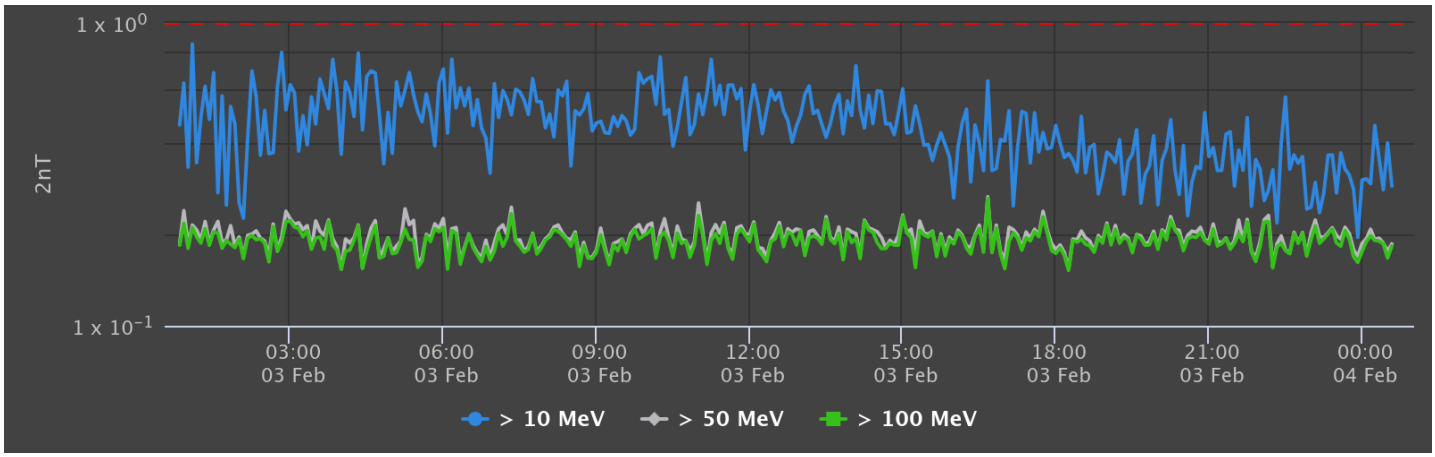
Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux remains a little above Background levels following the M6.8 flare on 29 Jan from Ex-AR3559, but remains well below the S1/Minor Radiation Storm threshold.

There remains a slight chance of reaching S1 levels should any of the regions on the disc produce any larger flares, although this is limited by the vast majority of regions lying in the less well-connected eastern solar hemisphere. The rapid growth and complexity of AR3575 make it the most likely region to produce a proton storm, particularly as continues to rotate into the favourable western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES16 Proton Flux trace – slightly elevated, but below the S1 threshold.



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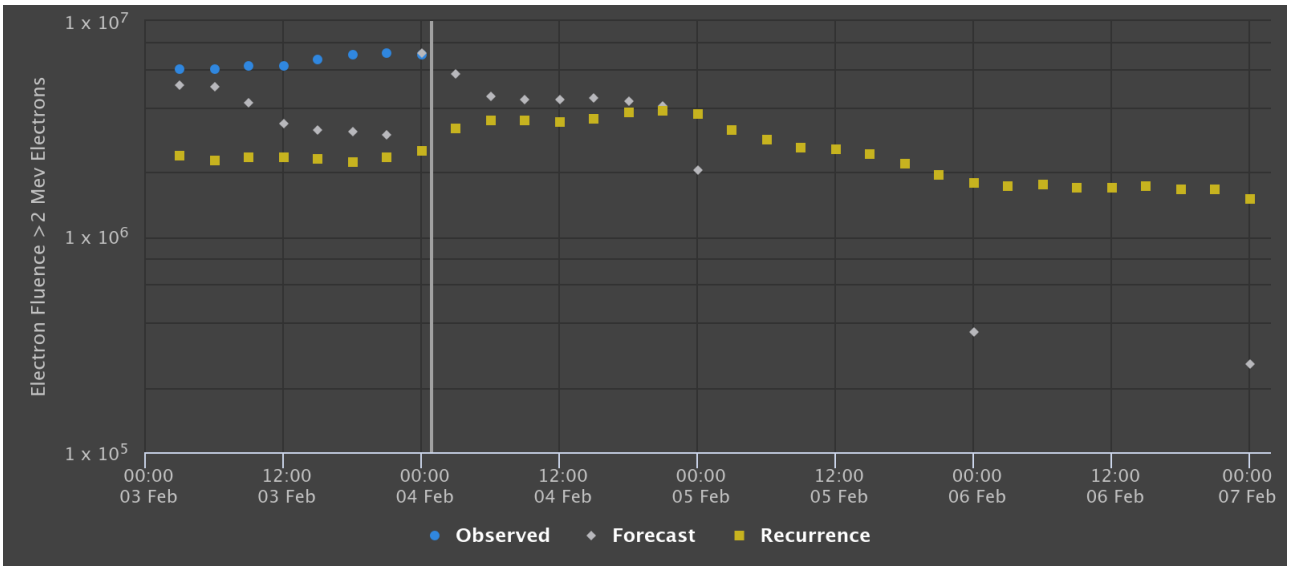
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been mostly at Background levels. Any CME or HSS effects during this period are most likely to be fairly weak, and lack impetus for a significant increase in electron flux. There is a very low risk of an increase later in the period, should there be a stronger response to the CME or inbound fast wind than expected.

Overall, the electron fluence is expected to remain well below the Active (1e8 integrated flux) threshold, perhaps with a slight rising trend later in the period. MOSWOC REFM's projections are currently underestimating the fluence, but still the overall below-Active trend is thought to be a good guide.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM electron fluence – observations, forecast and recurrence.



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